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Impacts and risks associated with a Greenland Halibut (*Reinhardtius hippoglossoides*) gillnet fishery in inshore areas of NAFO Subarea 0

Impacts et risques connexes d'une pêche au filet maillant visant le flétan du Groenland (*Reinhardtius hippoglossoides*) dans les secteurs côtiers de la sous-zone 0 de l'OPANO

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ABSTRACT

Fisheries and Oceans Canada (DFO) Fisheries and Aquaculture Management has requested advice on the potential impacts and associated risks of the development of an inshore Greenland Halibut gillnet fishery in coastal areas of Baffin Island. This research document has been compiled in response to this request.

Gillnets used to capture Greenland Halibut are typically large mesh nets (6"-9" or 153 mm -229 mm) set on the bottom in very deep water (>500 m). The fishing season under review is from 1 July to 10 November and generally corresponds to the open water season. Beluga, Narwhal and Bowhead whales, as well as seals (Ringed, Bearded, Harp), Walrus and Greenland Shark inhabit potential fishing areas along the Baffin Island coast and would all be at risk of entanglement in gillnets set for Greenland Halibut or nets that may become lost during Greenland Halibut fishing. Also, a gillnet-only fishery for Greenland Halibut is not optimal given the high female to male ratio caught by this gear. Longline gear poses fewer risks to the ecosystem of east Baffin Island and should continue to be used in both winter and summer fisheries in inshore areas.

RÉSUMÉ

Gestion des pêches et de l'aquaculture de Pêches et Océans Canada (MPO) a demandé que soit formulé un avis sur les impacts potentiels et les risques connexes d'une nouvelle pêche au filet maillant visant le flétan du Groenland dans les secteurs côtiers de l'île de Baffin. Le présent document de recherche a été élaboré pour répondre à cette demande.

Les filets maillants utilisés pour pêcher le flétan du Groenland sont d'ordinaire des filets à grand maillage (6-9 po ou 153-229 mm) déployés sur le fond à de très grandes profondeurs (> 500 m). La saison de pêche examinée se déroule entre le 1er juillet et le 10 novembre, période correspondant généralement à la saison des eaux libres. Le béluga, le narval, la baleine boréale, le phoque (annelé, barbu et du Groenland), le morse et le requin du Groenland, qui sont présents dans les zones de pêche potentielles situées le long de la côte de l'île de Baffin, risquent donc de s'emmêler dans les filets maillants déployés pour capturer le flétan du Groenland ou dans des filets perdus pendant cette pêche. En outre, la pratique d'une pêche au filet maillant uniquement n'est pas optimale dans le cas du flétan du Groenland étant donné la grande proportion de femelles capturées par cet engin. La palangre présente moins de risques pour l'écosystème de l'est de l'île de Baffin, c'est pourquoi on devrait conserver cet engin pour les pêches d'hiver et d'été dans les secteurs côtiers.

INTRODUCTION

Since the mid-1980s several inshore areas along the east coast of Baffin Island have been explored for commercial concentrations of Greenland Halibut. At this time, Cumberland Sound is the only area where an inshore fishery has been established.

The Cumberland Sound Greenland Halibut (Turbot) fishery began in 1986 and has been traditionally exploited during the winter months using longline gear set under the ice. Fishing typically takes place along a deep trench (>500 m) that extends between Imigen Island and Drum Islands, and Kikistan Islands. In 2005, a management zone was established in Cumberland Sound with a Total Allowable Catch (TAC) of 500 t separate from the Northwest Atlantic Fisheries Organization (NAFO) Division 0B TAC. Catches in the winter fishery peaked in 1992 at 430 t then declined to levels below 100 t through the late 1990s and peaked again at 245 t in 2003. From 2005 to 2008 catches were very low with harvests of 9 t, 70 t, 3 t and 32 t, respectively (DFO 2008a and Treble, DFO, unpubl. data). In 2009, catches increased to 156 t. The periods of decline have been attributed to poor ice conditions and reduced fishing effort which tend to be correlated. Recently there has been interest in fishing the quota remaining from the winter fishery in the open water season as well as exploring deeper areas (500 m to 1000 m) in the centre of Cumberland Sound, outside the winter fishing grounds.

Several other inshore areas along the Baffin coast have deep water habitat (>500 m) that may support concentrations of Greenland Halibut. Through-ice exploratory fisheries have shown potential for a winter inshore fishery in Scott Inlet/Sam Ford Fiord north of Clyde River (Walsh 2003a, 2006a, 2008) and Eclipse Sound near Pond Inlet (Fig. 1) (Walsh 2003a, 2006b). There is also interest in developing a near-shore summer fishery in these coastal areas. Based on bathymetry and connection to offshore waters other areas most likely to support concentrations of Greenland Halibut are: Jones Sound, Buchan Gulf and Home Bay (Fig. 1). The open water season might vary slightly from one area to the other but typically occurs from July/August to November. The relationship between Greenland Halibut stocks in these areas is unknown.

Three gear types are typically used to catch Greenland Halibut in open water: bottom otter trawl, longline (comprised of baited hooks that lie along the sea floor attached to the surface by float lines) and bottom-set gillnet. All three gear types have been used in the offshore Greenland Halibut fishery although in recent years longlines have been phased out (Treble *et al.* 2007). All three gear types are used in Greenland Halibut fisheries in other jurisdictions, except for Alaska where longline is the only gear used in the Gulf of Alaska and Bering Sea fisheries (North Pacific Fishery Management Council 2008a, b). However, in southern Canada and most other jurisdictions longlines or gillnets are typically used in inshore areas. Longlines are currently used in the Cumberland Sound fishery, however, there has been a request to introduce gillnets (DFO 2008b).

Gillnets used to capture Greenland Halibut are typically large mesh nets (6"-9" or 153 mm-229 mm) 91 m in length. These nets are strung together to create net gangs of 200 or more individual nets which are set on the bottom in very deep water (>500 m). In Nunavut, Arctic Char are caught with gillnets in near-shore waters, however the gillnets used are smaller mesh nets (typically 5.5" or 139 mm or less) of approximately 100 m set in shallow water, relatively close to shore. Arctic Char nets are generally not strung together in long net gangs and therefore the overall length of gillnets are much shorter for the Arctic Char fishery.

DFO Fisheries Management has requested advice on the potential impacts and associated risks of the development of an inshore Greenland Halibut gillnet fishery in coastal areas of Baffin Island. This research document has been compiled in response to this request.

ASSESSMENT

DIRECT IMPACTS

Based on the Cumberland Sound experience, other Greenland Halibut fisheries along the east coast of Baffin Island would be expected to occur at depths > 500 m. The fishing season being considered in this review is the open water season which generally runs from 1 July to 10 November. Although the request for science advice specified Narwhal, Bowhead and Beluga as the focus, other marine mammals frequent the inshore areas along the Baffin Island coast, some in large numbers, many in sizeable herds, and are also vulnerable (Table 1). Bycatch of Greenland Shark is an added concern.

- NARWHAL occupy the fiords and nearshore areas in summer (Fig. 1 and 2). The area is the route of fall migration for a large component of Canada's Baffin Bay-High Arctic Narwhal population (Somerset Island, Admiralty Inlet, Eclipse Sound and East Baffin Island stocks). Narwhal are known to dive to >800 m, likely foraging (Laidre and Heide-Jørgensen 2004, Laidre 2003).

- BOWHEAD occupy the fiords and nearshore areas in August (Figs. 3 and 4). The region has been identified as important bowhead habitat (DFO 2008e, Finley 2001, Heide-Jorgensen *et al.* 2003, 2006). Bowhead occupying this area are part of the Eastern Canada-West Greenland population (Heide-Jørgensen *et al.* 2006, COSEWIC 2009). Bowhead whales have been recorded to dive to nearly 500 m (Laidre *et al.* 2007). There have been reports of bowhead whales entangled in gillnets in Greenland and Canadian waters.

- BELUGA are not numerous in the areas under consideration except in spring in Pond Inlet and the ice edge of Eclipse Sound. Dive data from tagged beluga indicate that their habitat overlaps with Greenland Halibut fishing depths: most dives were in the 200-600m range with several dives > 900 m.

It is well documented that deep sea gillnets pose a risk to marine mammals (Dayton *et al.* 1995, Laist *et al.* 1999 in Dayton *et al.* 2002) throughout their ranges. Bowhead whales have become entangled in harpoon lines and in fishing nets and lines (Philo *et al.* 1992, Angliss and Outlaw 2008). Inuit have also reported Bowhead whales swimming into nets set for Belugas, Narwhals and Arctic Char in Cumberland Sound and in the adjacent Pangnirtung Fjord, resulting in destroyed nets and entanglement (NWMB 2000). Four bowheads have been reported entangled in nets in Nunavut and West Greenland since 2003 (DFO, unpubl. data).

In the Baffin Bay (Div 0A) Greenland Halibut fishery there have been four reports of marine mammal entanglements in the past six seasons; a narwhal was seen struggling at the surface, entangled in a line with a large float attached in 2004; individual sperm whales have been caught in Greenland Halibut gillnets each year in 2007, 2008 and 2009. In 2008 the nets had been left soaking for 9.5 days.

Greenland Shark is abundant in nearshore waters of Baffin Bay and are vulnerable to entanglement in Greenland Halibut gillnets and to becoming hooked and entangled in longlines. Exploratory fisheries conducted in 1993 (near Qikiqtarjuaq) and 1994 (Davis Strait, Resolution Island and Cumberland Sound) evaluated several gear types, including gillnets (Hathaway 1993, Northlands Consulting 1994). In 1993, they reported catching three seals in gillnets but could not identify the species and they ran into severe problems with ice, a string of 23 nets was lost but later recovered 10 miles from its original location (Hathaway 1993). In both years, they reported significant bycatch of Greenland Shark (52 sharks in 11 gillnet sets in 1993). The sharks tore the nets, raising concerns about the potential for losing gillnets in a commercial fishery. Northlands Consulting (1994) recommended that gillnets not be used if a fishery for Greenland Halibut was developed.

In 2003, a fishery training course was conducted in Cumberland Sound where 12 sharks, 113 skates and 198 Greenland Halibut were caught over 10 longline sets (Walsh 2003b). A longline fishery conducted during summer 2009 in Cumberland Sound also encountered high bycatch of Greenland Shark with 570 caught in 55 sets over an eight week period, approximately half of which were able to be released alive. The potential for live release would be low for Greenland sharks caught in gillnets. Usually longline caught fish are still alive when they are brought onboard and it is possible that bycatch species could survive capture if handled carefully and released.

Generally the whole area has seals and whales present for significant periods throughout the year. Many of these marine mammal species are gregarious, meaning the encounter of a net by one usually means the encountering of the net by many. Because the time, area and depths "fished" by lost nets cannot be controlled, gillnets are a hazard to marine mammals.

Beluga, Narwhal and Bowhead whales, as well as seals (Ringed, Bearded, Harp), Walrus and Greenland Shark would all be at risk of entanglement in gillnets set for Greenland Halibut or nets that are lost during Greenland Halibut fishing.

INDIRECT IMPACTS

Gear Loss

Humborstad *et al.* (2003) documented large catches of Greenland Halibut in ghost fishing gillnets off the coast of Norway in the Barents Sea and concluded that gillnets lost in that area continue to fish for long periods. Norway has implemented an annual net-retrieval program to address concerns with ghost fishing (Large 2009).

Concern over loss of gear and ghost fishing in deepwater gillnet fisheries prompted the European Community (EC) to place a temporary ban on gillnetting in waters > 200 m in 2005. The Northeast Atlantic Fisheries Commission (NEAFC) followed with a ban on gillnet fishing in depths > 200 m in their Regulatory Area beginning in 2006 (NEAFC 2006). In 2006, the EC management measures were revised to include a permanent ban in waters > 600 m and imposed limits on both the maximum length of nets deployed and the soak time for bottom-set gillnets in waters < 600 m (Large *et al.* 2009).

When gillnets are lost there is a high likelihood that they will continue to fish or "ghost fish" for months and sometimes years impacting both target species (in this case Greenland Halibut) and non-target species including marine mammals and sharks (Dayton *et al.* 1995, Cooper *et al.* 1988). Ghost fishing also includes mortality of non-target species, in non-target areas,

depending on the drift patterns of the lost nets. Key causes of gear loss identified by a European study were listed in decreasing order of importance (Brown and Macfadyen 2007):

- conflict with other sectors, principally towed gear operators;
- working in deep water;
- working in poor weather conditions and/or on very hard ground;
- working very long fleets; and
- working more gear than can be hauled regularly.

Working in deepwater, in poor weather conditions, and on very hard bottom are all relevant to Greenland Halibut fisheries off Baffin Island. Greenland Halibut are most abundant in deep waters and the inshore fisheries are likely to be concentrated in water >500 m. In the fjords along the coast these deep areas are found in narrow trenches or deep holes with rough, rocky bottom habitat and subject to strong tides and currents. Strong currents and rough bottom habitat would compound the risk of losing nets in these areas and would reduce the chance of recovering nets that become lost. In addition weather and ice conditions in the Arctic can be severe and unpredictable presenting a greater risk of gear loss than in more temperate areas. Gillnets have been lost due to ice in Greenland Halibut fisheries in offshore areas of Baffin Bay (Div. 0A).

Since the introduction of gillnets to the Div. 0A Greenland Halibut fishery, nets have been inadvertently lost in every fishing year (Table 2). To date, approximately 739 nets have been lost, or approximately 74 km (each net is approximately 100 m). An additional 50 nets have been lost but were retrieved. Some of the gear loss in 2007 was attributed to sea ice and a Sperm Whale entanglement. This fishery has had complete observer coverage since it began in 1996.

In the Div. 0B Greenland Halibut fishery for 2007, there was not complete observer coverage of the gillnet fleet but there were two reports of lost nets (231 nets lost with only 50 retrieved).

Gear Selectivity

Nedreeas *et al.* (1996) compared gear selectivity in the Barents Sea Greenland Halibut fishery using a 220 mm (8.5") and 180 mm (7") mesh gillnet, a bottom trawl with cod mesh 135 mm (5 1/4") and a longline (hook size 12/0). They found that the size distribution of the longline catch was wider than that taken by gillnet. In addition, gillnets caught almost exclusively mature females (about 90%) while approximately 70% of the longline catch and 60-70% of the trawl catch was mature fish.

A similar pattern in gear selectivity is seen between gillnets and longlines in the Div. 0A fishery (Fig. 5) where mesh size ranges from 190 mm (7.5") to 208 mm (9") and the longline hook size was a #14 (circle). Biological samples taken from offshore catches in NAFO Division 0A showed that females comprised 72%-80% of the Greenland Halibut catches by number for gillnets in 2005-2007 and 64%-72% for longlines in 2002 and 2003 (Treble, DFO, unpubl. data). The Cumberland Sound winter longline fishery catch is comprised of almost equal numbers of males and females (DFO 2008a).

In the Newfoundland and Labrador inshore Greenland Halibut fishery gillnets had replaced the traditional longline by the late 1960s, fishing effort increased dramatically and within a few years most of the bays along the coast were fished out (Bowering and Brodie 1995). By the late 1980s, fishermen had moved further offshore to deepwater areas along the shelf slope. In 2001,

the use of gillnets was being discouraged in inshore areas of Newfoundland and Labrador (Andrew Duthie, DFO, pers. comm.) although this is no longer the case today.

A gillnet-only fishery for Greenland Halibut is of concern given the high female to male ratio for this gear. This may be particularly relevant for Subarea 0 (offshore and inshore areas) where that portion of the population that is contributing to reproduction is reduced due to late maturity and skip-spawning (Fig. 6). The colder environment in this high latitude location could be a contributing factor to the observed reproductive pattern (Harris *et al.* 2009), making Greenland Halibut in these northern areas vulnerable to a gillnet-only fishery.

Ecosystem Impacts

Ecosystem effects of different gear types should be considered. Information on the presence of sensitive benthic habitat features such as corals and sponges is generally not known in these frontier areas. Bottom set gillnets could pose a greater risk to benthic habitats than longline gear (Chuenpagdee *et al.* 2003; Fuller *et al.* 2008). Removal of non-target prey species for Greenland Halibut and marine mammals has not been assessed, nor has competition for size-classes of Greenland Halibut between the fishery and Narwhal and other Greenland Halibut predators.

SPECIES AT RISK

Entanglement in fishing gear and "ghost nets" would add an additional potential threat to marine mammal populations which have been assessed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) (Table 3). Narwhal, Walrus and Eastern Canada-West Greenland Bowhead and Eastern High Arctic-Baffin Bay Beluga are designated as Special Concern. Cumberland Sound Beluga are designated as Threatened. Narwhal and Sperm whales have been reported entangled in Greenland Halibut fishing gear set in the Div. 0A offshore fishery.

MITIGATION

Fixed Gear Regulations in Greenland Halibut Fisheries

DFO Central and Arctic Region (NAFO SA0)

The Greenland Halibut management plan requires:

1) a minimum gillnet mesh size of 153 mm (6") be used in water depths < 730 m
2) a minimum gillnet mesh size of 190 mm (7.5") be used in depths > 730 m
3) a maximum number of 500 nets of 50 fathoms (91.4 m) each (approx. 46 km/vessel).
4) the minimum hook size for longlines is a #14 circle hook.

Additional license measures implemented in 1998 require that tags be attached to all gillnets when fishing and that any lost nets or tags must be report. Observer coverage of the gillnet fleet was also implemented in 1998 (DFO 1999).

DFO Newfoundland and Labrador Region (NAFO SA2&3)

Fishing with both gillnets and longlines is restricted to deeper depths (>293 m or >549 m, depending on the area) to avoid conflict with inshore crab fisheries. Authorized mesh size (6",

7.5") and number of nets (125, 200, 300, 400) varies with depth and fishing area. Gillnets must not exceed 91 m and require tags. Any lost nets must be reported (DFO 2008c).

DFO Quebec Region (NAFO Div. 4RST)

Gillnets are limited to 90 or 120 (depending on the area) nets of 50 fathoms (91.4 m) with minimum mesh size of 152 mm (6"). The fishing season is April to October with a portion of Div. 4T excluded from the fishing area (DFO 2008d).

Greenland

The fishery in the Greenland fiords was traditionally a longline fishery. In the 1980s gillnets were introduced, by the late 1990s authorities introduced regulations limiting areas where gillnets could be used and in 2000 a total ban on gillnets was implemented. However, since 2004 authorities in Uummannaq and Upernavik municipalities have been allowed to set local fisheries regulations and gillnets with minimum mesh size of 110 mm (approx. 4.5") are now permitted in some areas (Lyberth and Boje 2006).

Norway

The Greenland Halibut fishery is restricted to longline and gillnet vessels that are less than 28 m (92 feet) long. Trawl catches are limited to by-catch from other fisheries only. http://www.fisheries.no/Ecosystems-and-stocks/marine_stocks/fish_stocks/Fish_halibut/north_east_arctic_halibut/

The maximum soak time for gillnets set north of 62°N is 2 days and no fishing is permitted in this area between September 1 and April 30. In the Storegga area gillnets are restricted to 18 fleets $\leq$ 25 nets (450 nets total) and fishing is not allowed during September 1 to April 30. Longline vessels that are larger than 21.35 m and that have auto longline systems are not allowed to fish within 4 nm of the coast. In certain areas these vessels are not allowed to fish within 10 nm of the coast between September 1 and December 31 and in one area the season is closed from September 1 to April 30 (Norway 2009).

Alaska

In the Bering Sea and Gulf of Alaska gillnets are not permitted and the fishery is almost exclusively a longline fishery. Bottom trawls are allowed but halibut bycatch restrictions effectively prohibit the use of trawl gear to target Greenland Halibut. There are several areas that have been fully closed to fishing or are closed seasonally, depending on the gear type. (North Pacific Fishery Management Council 2008a, b).

European Council

In ICES Zones VI a, b, VII b, c, j, k and XII gillnet fishing has been banned in waters > 600 m since 2007. In waters < 600 m the following is permitted:

a) *"Gillnets with a mesh size equal to or greater than 120 mm and less than 150 mm, provided that they are deployed in waters of less than 600 metres charted depth, are no more than 100 meshes deep, have a hanging ratio of not less than 0.5, and are rigged with floats or equivalent floatation. The nets shall each be of a maximum of 2.5 km in length, and the total length of all nets deployed at any one time shall not exceed 25 km per vessel. The maximum soak time shall be 24 hours; or*

b) Entangling nets with a mesh size equal to or greater than 250 mm, provided that they are deployed in waters of less than 600 meters charted depth, are no more than 15 meshes deep, have a hanging ratio of not less than 0.33, and are not rigged with floats or other means of floatation. The nets shall each be of a maximum of 10 km in length. The total length of all nets deployed at any one time shall not exceed 100 km per vessel. The maximum soak time shall be 72 hours".

(Council Regulation (EC) No. 41/2006, Annex 3, Part A, Clause 9: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2007:015:0001:0213:EN:PDF)

Previous Recommendations Concerning Gillnet Regulations in the Subarea 0 Greenland Halibut Fishery

In February 1996, the NWMB passed Resolution #96-082 (NWMB 1996a) "that NWMB write to the Minister of DFO, suggesting the following non-quota limitations in the offshore areas of Subarea 0:

1) That the number of gillnets per vessel be limited;
2) That hanging twine in gillnets be biodegradable;
3) That use of longlines be encouraged, not prohibited.

Also moved, that the same restrictions be drafted for application within the marine waters of the NSA." (NWMB 1996a).

Concerns over the use of gillnets in the Greenland Halibut fishery were re-iterated during the May 1996 NWMB meeting and the minutes indicate a letter was sent to the DFO Minister on March 11, 1996 making recommendations for the control of gillnetting (NWMB 1996b).

The Parliamentary Standing Committee on Fisheries and Oceans (Canada 1998) made three recommendations in their report tabled on December 8, 1998 that came out of consultations with residents of Iqaluit, Qikiqtarjuaq and Pangnirtung:

1) Recommendation # 4 called on DFO to encourage the use of gear types other than gillnets in the Davis Strait fishery, particularly the use of long lines;
2) Recommendation # 5 called on DFO to limit soak times to ensure a high product quality and to minimize waste; and
3) Recommendation # 6 called on DFO to support further research to determine the extent of "ghost net" fishing and if warranted consider a ghost net retrieval program or consider requiring biodegradable net components.

In 2003, DFO Science recommended against the introduction of gillnets into the offshore Greenland Halibut fishery in Division 0A citing conservation concerns (DFO, unpubl. report). The risk of marine mammal entanglement and the risk of losing nets were considered to be greater in Div. 0A than in the adjacent fishing area (Div. 0B) due to differences in marine mammal abundance, ice and weather conditions. In 2008, DFO Science recommended against the use of gillnets in the Greenland Halibut fishery in Cumberland Sound (DFO 2008b).

Recommendations Based on the Current Review

Greenland Halibut fishers could use an alternative geartype to gillnets. Longline gear is used in other jurisdictions. The anchor and float lines for both longlines and gillnets can pose a risk of entanglement for marine mammal species. However, this risk is considered lower than the overall risk posed by gillnets (Chuenpagdee *et al.* 2003; *Fuller et al. 2008*). Longline gear will catch Greenland Shark but there is a lower risk of mortality compared to gillnets. Ghost fishing impacts to Greenland Halibut and other fish and marine mammals is greater with gillnets. Also,

longline gear selectivity results in a distribution of Greenland Halibut catch that includes a better balance of both sexes and a broader size range which poses less risk to the sustainability of the Greenland Halibut stocks.

Assigning independent onboard observers to the fishing vessels would assist in monitoring bycatch and in the identification of sensitive benthic habitat in these frontier areas.

Any new fishery will have ecosystem implications and the first step in mitigating these changes is an assessment of the ecosystem consequences arising from the removal of significant numbers and biomass of Greenland Halibut and bycatch species from the newly identified fishing areas.

SUMMARY

There is significant known risk to marine mammals, Greenland Shark and to inshore components of the Greenland Halibut population if gillnets are permitted in inshore areas of Baffin Island when fishing for Greenland Halibut.

1) The use of gillnets increases the probability that non-target species, particularly marine mammals and Greenland Shark, will become caught or entangled. There are risks of entanglement of Narwhal, Bowhead and Beluga whales as well as seals (Ringed, Bearded, Harp) and Walrus because of the overlap between their habitat and the inshore Greenland Halibut fishing grounds.
2) The risk of losing nets, which will continue to cause fish and marine mammal mortality, is high. Severe ice conditions can be encountered throughout the year, in addition strong currents and rough bottom increase the likelihood of losing gear that will continue to fish or present an underwater hazard, further impacting fish and marine mammals.
3) Gillnets selectively remove large mature female Greenland Halibut posing a greater threat to the population than longline gear which catches a broader size range and lower proportion of females. Monitoring programs might not detect an impact in time to reverse declines in abundance that could result from a gillnet-only fishery.
4) Gillnet caught fish are usually dead and damaged by the twine or by Greenland Shark that are caught along with them in the nets. Longline caught fish are usually still alive when they are brought onboard, resulting in a better quality product and there is a chance that bycatch could survive capture and released live if handled carefully.

There are unknown risks to ecosystem dynamics from the removal of Greenland Halibut and bycatch species from newly fished areas, including direct impacts to benthic habitat.

Longline gear poses fewer risks to the marine ecosystem of east Baffin Island and should continue to be used in both winter and summer fisheries in inshore areas.

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Table 1. Marine mammals and the potential fishing areas

Potential Fishing Area	Beluga	Narwhal	Bowhead	Other Marine mammals
Jones Sound	spring and fall migration route, western edge of Northwater Polynya over-wintering area	spring and fall migration route, summering area	spring and fall migration route	Ice edge over-wintering and calving area for walrus, summering area for harp seals (large herds), year-round habitat for ringed and bearded seals
Pond Inlet	Spring migration route	spring and fall migration route, summering area	spring and fall migration route, summering area	summering area for harp seals (large herds), year-round habitat for ringed and bearded seals
Eclipse Sound	Spring migration route (ice edge)	spring and fall migration route, summering area	spring and fall migration route, summering area	summering area for harp seals (large herds), year-round habitat for ringed and bearded seals
Buchan Gulf		Summering area, fall migration route	Summering area	year-round habitat for ringed and bearded seals
Scott Inlet		Summering area, fall migration route	Summering area	year-round habitat for ringed and bearded seals
Sam Ford Fiord		Summering area, fall migration route	Summering area	year-round habitat for ringed and bearded seals
Home Bay		Summering area, fall migration route	Summering area, fall migration focal area	year-round habitat for ringed and bearded seals

Table 2. Number of gillnets lost in Div. 0A Greenland Halibut fishery since their introduction in 2004. (Data for 2009 not yet available).

Year	Number of Nets Lost	Approx. Length of Nets Lost
2004	174	17 km
2005	291	29 km
2006	170	17 km
2007	84	8 km
2008	>20*	>2 km

* Number of nets lost due to Sperm whale entanglement not known.

*Table 3. Marine mammal species occurring in NAFO Subarea 0 and their most recent COSEWIC designation (http://www.cosewic.gc.ca/eng/sct0/rpt/rpt_csar_e.pdf). **Bold** indicates the species has been reported entangled in fishing gear in Division 0A.*

Species	Population Assessed	Species Occurrence in 0A	Assessment Date	COSEWIC Designation
Bowhead *Balaena mysticetus*	Eastern Canada-West Greenland	Open water season, widely distributed, migration route	April 2009	Special Concern
Beluga *Delphinapterus leucas*	Cumberland Sound	Year-round, restricted distribution	May 2004	Threatened
	Eastern High Arctic-Baffin Bay	Open water season, clumped distribution	May 2004	Special Concern
Narwhal *Monodon monoceros*		Open water season, widely distributed, migration route	November 2004	Special Concern
Walrus *Odobenus rosmarus rosmarus*		Year-round, intermittent, clumped distribution	April 2006	Special Concern
Bearded Seal *Erignathus barbatus*		Year-round, widely distributed	April 2007	Data deficient
Ringed Seal *Phoca hispida*		Year-round, widely distributed	April 1989	Not at risk
Harp Seal *Phoca groenlandica*		Open water season, common, clumped distribution	Not assessed	
Northern Bottlenose Whale *Hyperoodon ampullatus*	Davis Strait	Offshore	April 1993	Not at risk
Harbour Porpoise *Phocoena phocoena*	Northwest Atlantic	uncommon	April 2006	Special Concern
Harbour Seal *Phoca vitulina concolor*		uncommon	November 2007	Not at risk
Hooded Seal *Cystophora cristata*		uncommon	April 1986	Not at risk
North Atlantic Minke Whale *Balaenoptera acutorostrata*		Present offshore, range extends to ~80 N	April 2006	Not at risk
Humpback Whale *Megaptera novaeangliae*	Western North Atlantic	Range extends to ~70 N	May 2003	Not at risk
Sei Whale *Balaenoptera borealis*	Atlantic	Range to ~65 N, potential visitor	May 2003	Data deficient
Long-finned Pilot Whale *Globicephala melas*		Range extends to ~60 N, potential visitor	April 1994	Not at risk
Sperm whale *Physeter macrocephalus*		Range extends to ~60 N, potential offshore visitor	April 1996	Not at risk
Blue whale *Balaenoptera musculus*	Atlantic	Rare visitor at best, offshore	May 2002	Endangered
Atlantic White-sided Dolphin *Lagenorhynchus acutus*		Range extends to ~65 N in Greenland, potential visitor	April 1991	Not at risk
White-beaked Dolphin *Lagenorhynchus. albirostris*		Range extends to ~65 N in Greenland, potential visitor	April 1998	Not at risk

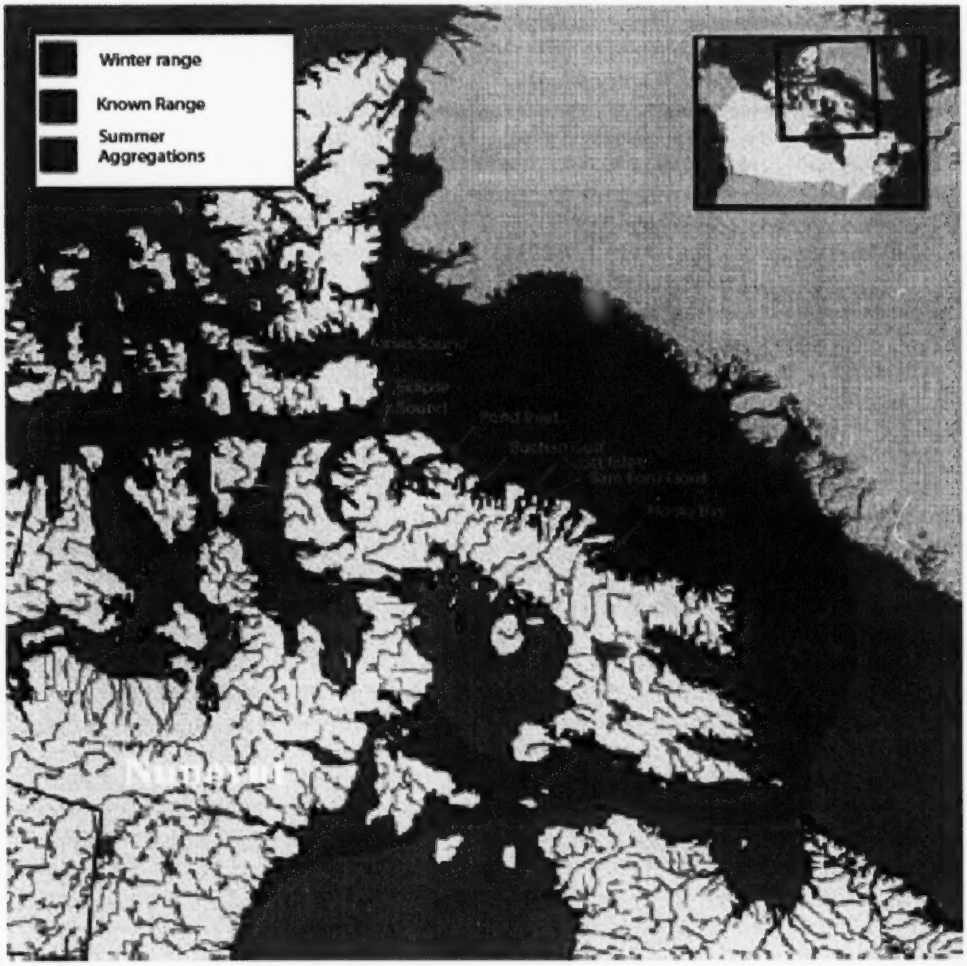

Figure 1. Summering grounds of narwhal (bright red) along eastern Baffin Island, modified after http://www.dfo-mpo.gc.ca/species-especes/species/factsheet/factsheet_narwhal_e.asp (accessed 4 March 2009)

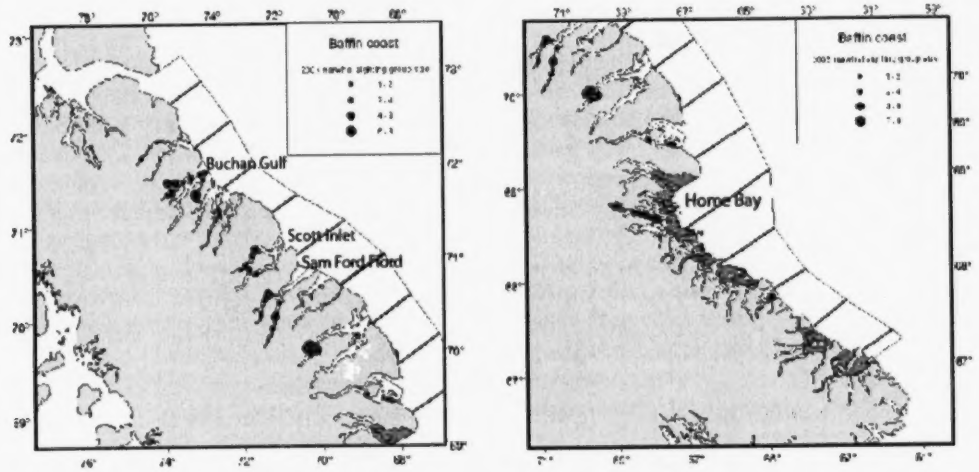

Figure 2. Narwhal on-transect sightings in August 2003. Left panel NE Baffin Island. Right panel Central east Baffin Island. Lines denote survey area. NOTE: only every other fiord was surveyed. (modified after Richard et al. 2010).

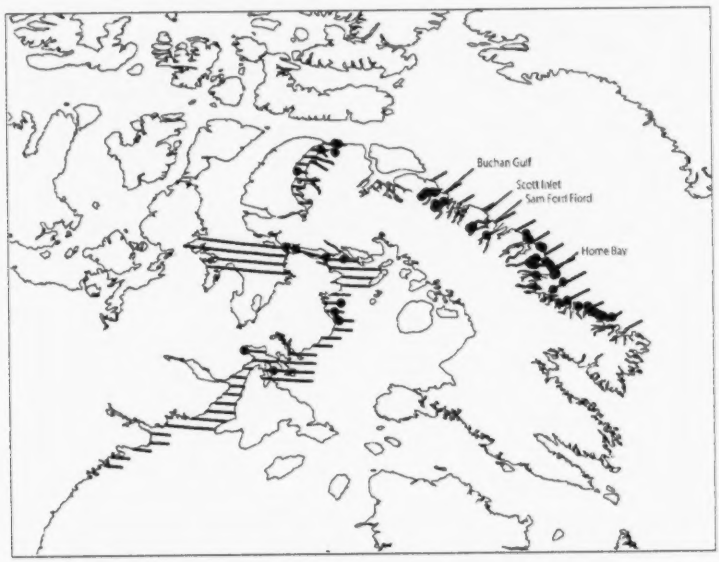

Figure 3. Transects and sighting locations of bowheads during August 2003 surveys of southern Gulf of Boothia, Foxe Basin and north-western Hudson Bay and Admiralty Inlet and east Baffin Island coast. (Cosens et al. 2006)

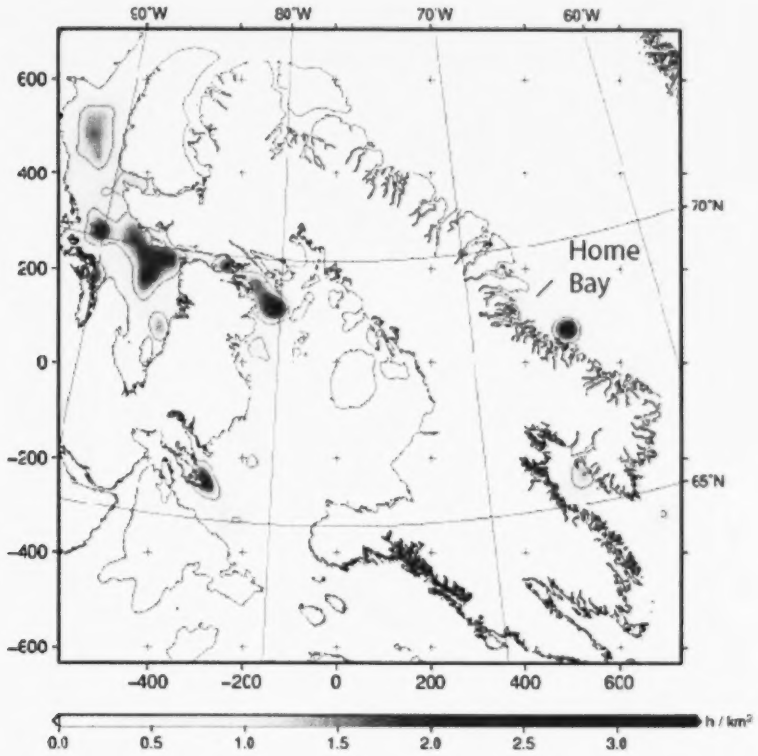

Figure 4. Temporal concentrations of bowhead whale use of the eastern Arctic in summer derived from all satellite telemetry locations of 6 bowheads tagged in northern Foxe Basin (July 2002 and 2003) and 8 in Cumberland Sound (May 2004 and July 2005-2006). Darker colour indicates greater time spent in the area. Faintly coloured area north from Home Bay along Baffin coast denotes travel area. The map represents an incomplete assessment of potentially important habitat and, it does not include data for whales tagged in Greenland (DFO 2008e).

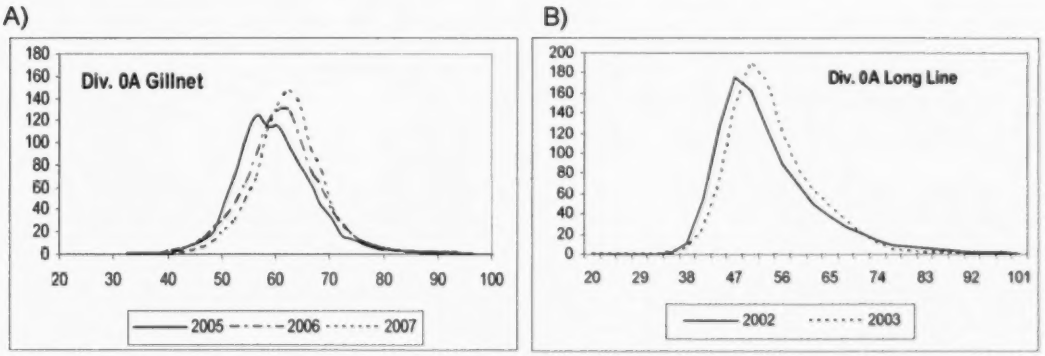

Figure 5.Gillnets (A) remove larger Greenland Halibut than do long lines (B) in the Div. 0A fishery, selectively removing the mature female size class.

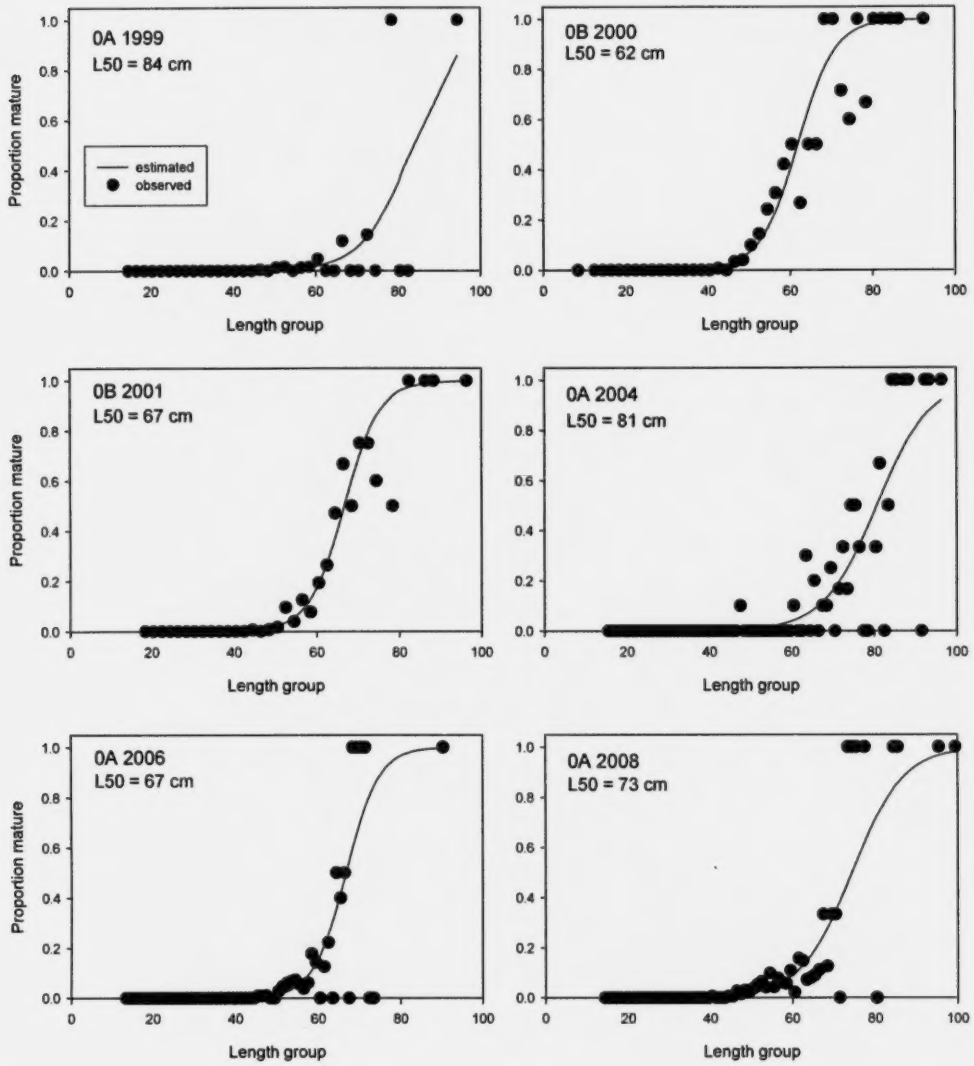

Figure 6. Estimated (line) and observed (symbols) proportion mature at length for female Greenland Halibut from surveys of Div. 0A and Div. 0B during 1999-2008. Note the larger size at maturity and presence of non-spawning females of spawning size for Div. 0A.